Claims

1. A method for measuring the intensity profile of an electron beam (10), in particular a beam of an electron-beam machining device, and/or for measuring an optical system (15) for an electron beam and/or for adjusting an optical system (15) for an electron beam, in which the electron beam is directed by relative movement between the electron beam and a measuring structure (16) on to different points (22, 20) of the latter which have different back-scattering properties, characterised in that a stream of electrons scattered in the reverse direction by the measuring structure (16) is measured as a function of the relative movement of the electron beam (10) and the measuring structure (16).

2. Method according to Claim 1, characterised in that a measuring structure (16) is used which includes at least one opening, in particular a slit or a circular hole, which allows the electron beam to pass through.

3. Method according to Claim 1, characterised in that a measuring structure (16) is used which includes at least one back-scattering surface which reflects the electron beam at least partially.

4. Method according to Claim 3, characterised in that the back-scattering surface is disposed perpendicularly to the mean direction of the electron beam.

5. Method according to Claim 4, characterised in that the back-scattering surface is carried by a raised element (22).

6. Method according to Claim 5, characterised in that the raised element is formed by a needle (22), preferably a metal needle, in particular of a heavy metal such as tungsten.

7. Method according to Claim 6, characterised in that the needle (22) is ground at its end.

8. Method according to Claim 6 or 7, characterised in that the axis of the needle (22) is disposed parallel to the mean direction of the electron beam.

9. Method according to any one of claims 2 to 8, characterised in that the slit, the hole or the back-scattering surface has in at least one direction a cross-sectional length which is shorter than the diameter of the electron beam.

10. Method according to any one of the preceding claims, characterised in that the stream of back-scattered electrons (24) is measured by means of a sensor ring (26) which preferably includes a plurality of sensor segments (28) distributed, preferably equidistantly, around the axis of the electron beam (10).

11. Method according to any one of the preceding claims, characterised in that the relative movement is generated by deflecting the electron beam by means of a magnetic field (14) or an electrical field.

12. Method according to any one of claims 1 to 11, characterised in that a measuring structure (16) is used which includes a plurality of slits and/or holes and/or back-scattering surfaces which are arranged at different distances from the incidence direction of the undeflected electron beam.

13. Method according to Claim 12, characterised in that a measuring structure (16) is used in which the slits, holes or back-scattering surfaces are distributed uniformly in the radial and/or the circumferential direction.

14. Method according to Claim 13, characterised in that a measuring structure (16) is used in which the holes and/or back-scattering surfaces are so aligned that their axes or normals pass through the principal point of the optical system (15).

15. Method according to any one of claims 1 to 14, characterised in that the back-scattering surfaces are circular.

16. Method according to any one of claims 1 to 14, characterised in that the back-scattering surfaces are in the form of narrow strips.

17. Method according to any one of claims 1 to 16, characterised in that the relative movement between the electron beam and the measuring structure takes place in two independent directions which lie substantially in a plane disposed perpendicularly to the incidence direction of the undeflected electron beam (10).

18. Method according to any one of claims 1 to 17, characterised in that a measuring structure (16) is used which has adjacently to the slits and/or openings and/or back-scattering surfaces a flat surface (20) of a material, in particular graphite, which back-scatters only weakly or not at all.

19. Method according to any one of claims 1 to 18 for measuring the optical system for an electron beam, characterised in that the cross-section of the electron beam is measured at a plurality of slits and/or openings and/or back-scattering surfaces which occupy different positions with respect to the incidence direction of the undeflected electron beam, and is compared to a cross-section of an electron beam as obtained by means of a correctly functioning optical system for an electron beam, and/or the imaging properties of the optical system (15) are measured.

20. Method according to Claim 19, characterised in that the measuring structure is in the form of a grid, in that at least a considerable portion of the grid is impinged upon by the electron beam through the relative movement between the electron beam and the measuring structure (16), the stream of back-scattered electrons as a function of the relative movement is converted into an image of the measuring structure and this image is compared to a reference image of the measuring structure as obtained by means of a correctly functioning optical system for an electron beam.

21. A method for compensating deflection errors of an optical system for an electron beam, wherein the imaging properties of the optical system (15) for the electron beam are determined using the method according to Claim 19 or 20 and at least one controllable component of the optical system is so adjusted that the difference between the actual image and the reference image of the measuring structure is minimised.

22. A measuring structure, in particular for use in a method according to any one of claims 1 to 21, characterised in that it has a base which includes at least one slit and/or one opening and/or one back-scattering surface.

23. Measuring structure according to Claim 22, characterised in that the planes of the slits and/or the axes of the openings and/or the normals of the back-scattering surfaces pass through a principal point of the optical system.

24. Measuring structure according to Claim 22 or 23, characterised in that the back-scattering surfaces are formed by end faces of needles (22) which are made preferably of metal, in particular of a heavy metal such as tungsten, and are carried by the base.

25. Measuring structure according to Claim 24, wherein the needle (22) is ground smooth at its free end, preferably substantially parallel to the flat surface (20) of the base.

26. Measuring structure according to any one of claims 22 to 25, characterised in that the flat surface (20) of the base is formed by a material, in particular graphite, which back-scatters weakly or not at all.

27. Measuring structure according to any one of claims 22 to 26, characterised in that it includes back-scattering strips (46) forming a grid and additionally includes at least one back-scattering surface (22) in each of the areas delimited by the edges of the grid meshes.

28. Measuring structure according to Claim 27, characterised in that the back-scattering surfaces (22) are located in each case at the centres of the areas delimited by the gridlines.

29. Measuring structure according to any one of claims 22 to 28, characterised by a collector plate (50) located downstream of said measuring structure, viewed in the direction of the beam.

30. An electron-beam machining device, comprising:
- a measuring structure according to any one of claims 22 to 29, and
- a back-scattered electrons measuring device (26) arranged in the electron beam path upstream of the measuring structure.

31. Electron-beam machining device according to Claim 30, characterised in that the back-scattered electrons measuring device includes a sensor ring (26) which preferably comprises a plurality of sensor segments

(28) distributed, preferably uniformly, in the circumferential direction.

32. Electron-beam machining device according to Claim 30 or 31, characterised by an optical system (15) which is electronically controlled by means of control signals of a control unit (30), a memory unit (30) at the same time detecting signals from the back-scattered electrons measuring device (26) as a function of the control signals.

33. Electron-beam machining device according to Claim 31, characterised in that the optical system (15), together with the control unit (30) and the back-scattered electrons measuring device (26), are designed to generate an image produced by scanning electron microscopy.

34. Electron-beam machining device according to Claim 31, characterised in that, in the case of a measuring structure (16) which has a substantially punctual back-scattering surface (22), in an optical system (15) for an electron beam, a focusing lens (12) is located upstream of a beam deflector unit (14), viewed in the direction of the beam.

35. Electron-beam machining device according to Claim 31, characterised in that, in the case of a measuring structure (16) which has an extensive back-scattering surface (22), in an optical system (15) for an electron beam, a focusing lens (12) is located downstream of a beam deflector unit (14), viewed in the direction of the beam.